Precipitation Interannual Variability and Seasonal Predictions for Africa

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Outline

- Principal mode of variability of seasonal rainfall

- NMME Model Performance

Data

- CPC gridded precipitation data
- GPCP
- ERSSTv3b
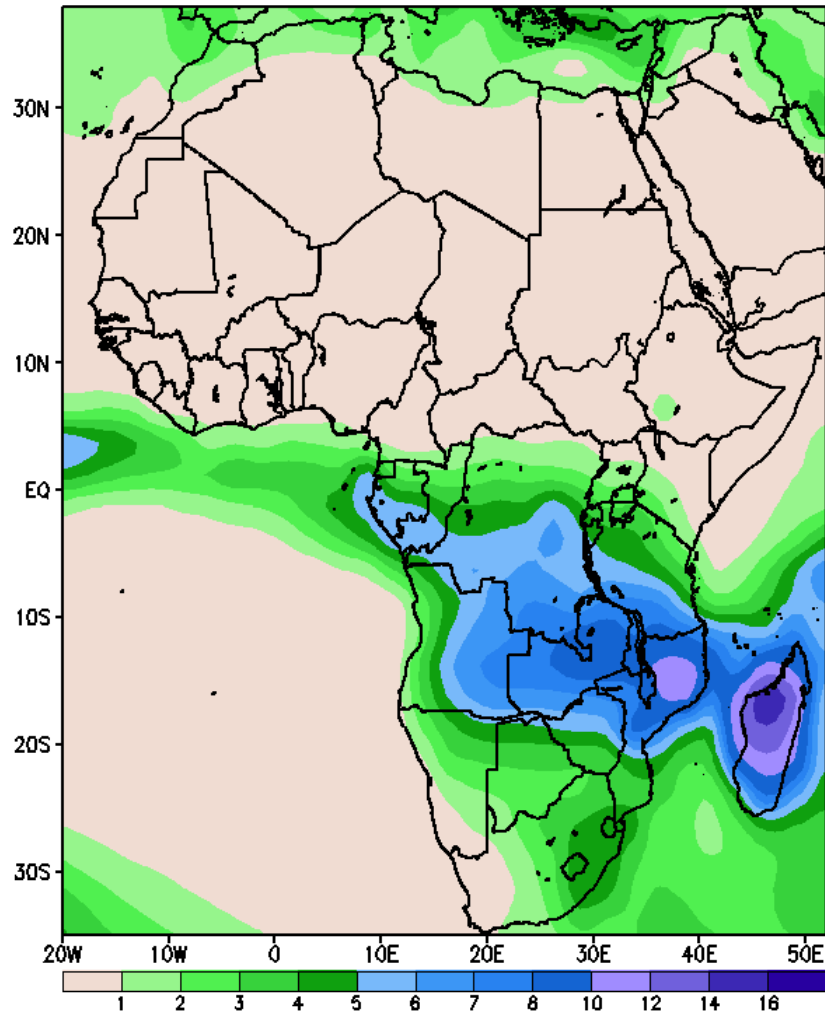- NMME outputs, zero lead

Methodology

- Perform EOF on seasonal rainfall
- Regress EOF time series over global SST fields
- Evaluate NMME model performance
- Apply CCA correction to NNME forecasts

Precipitation Seasonal Cycle

Precipitation 1982 - 2010

GPCP January precipitation totals in mm day⁻¹

Sub-Sahara regional precipitation features

Southern Africa: unimodal rainfall
- Southwestern IO and Aghulas currents
- South Atlantic Benguela Current

Equatorial eastern Africa: bimodal rains
- Equatorial IO and low level winds
- Congo rainforest air mass

Central Africa: rains almost year round
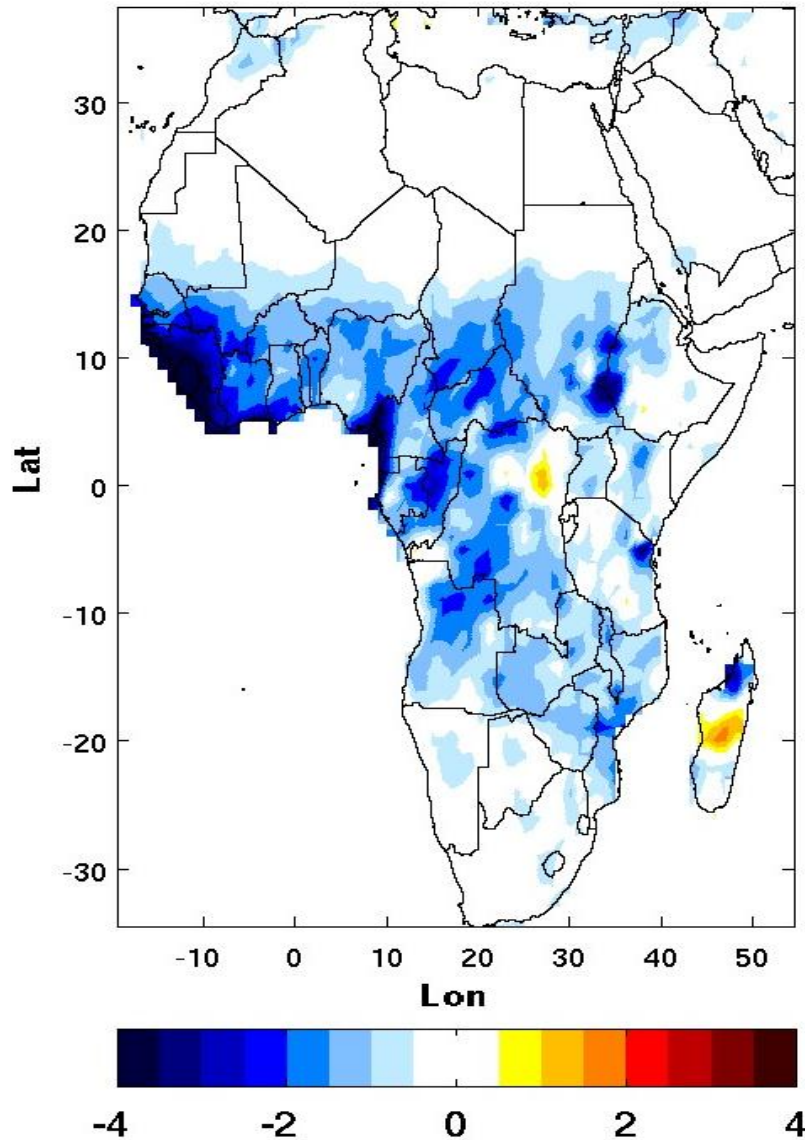- Mostly driven by local convection

West Africa
Gulf of Guinea region: bimodal
Sahel: unimodal
- Surface temperature gradient
- Heat low
- AEJ, TEJ, and low level westerly jet

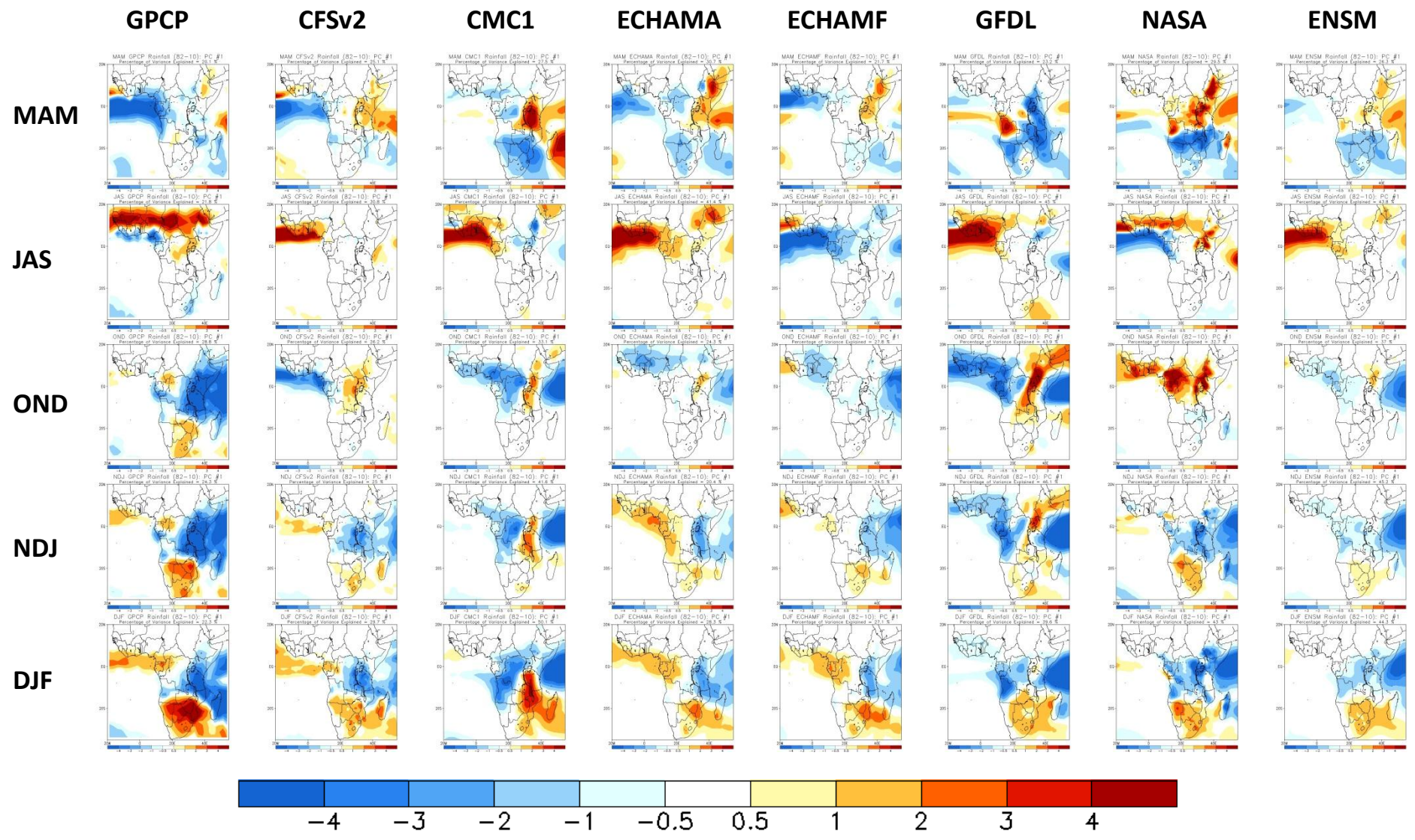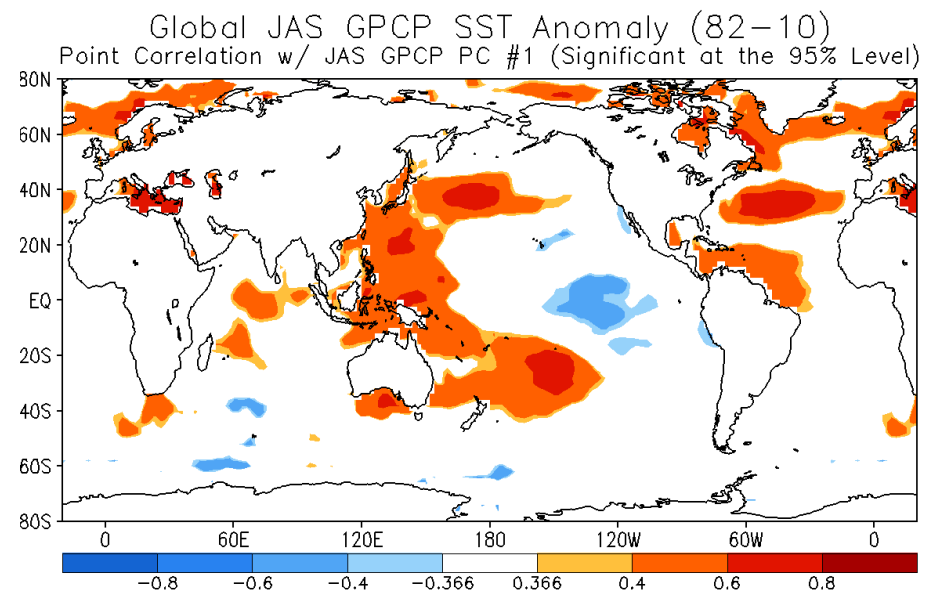# Dominant mode of annual precipitation anomaly

First Mode
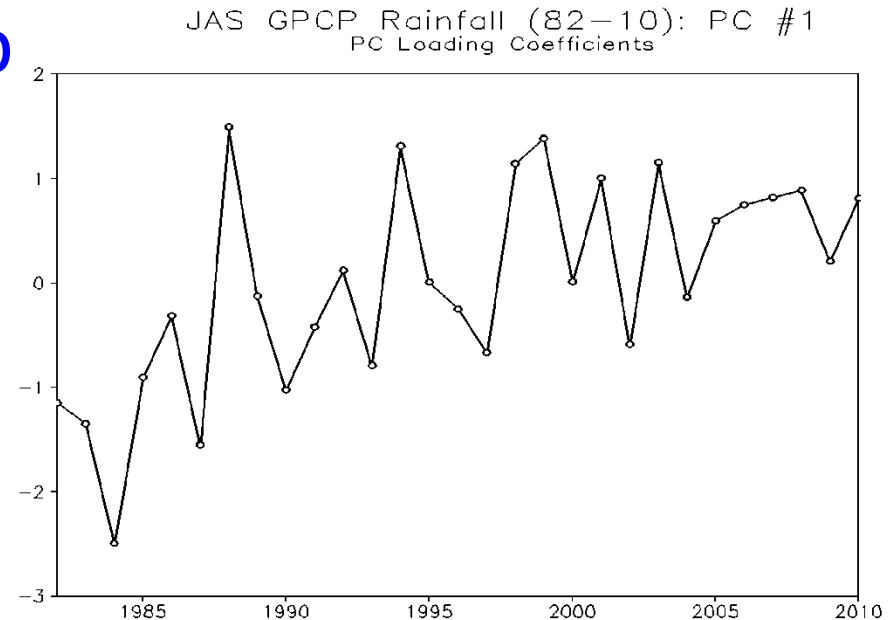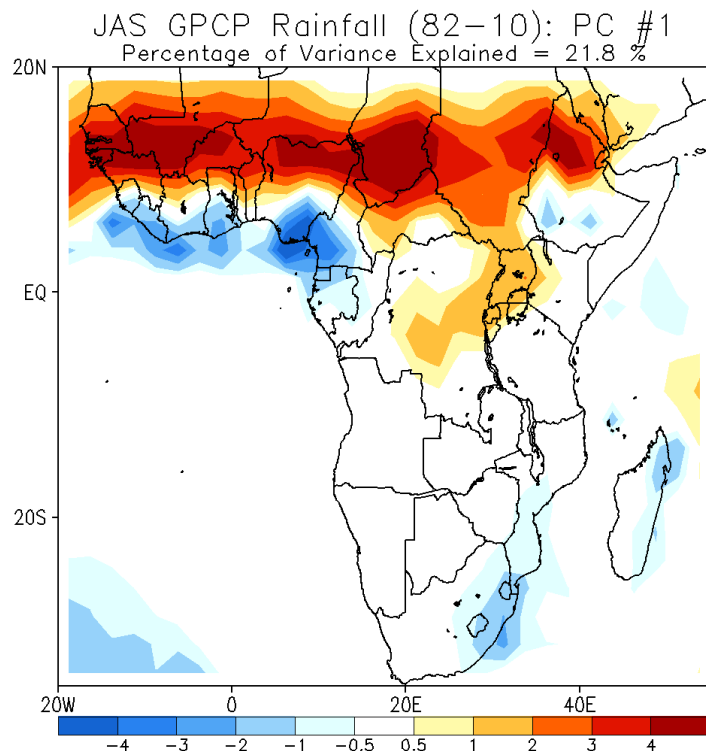
Third Mode
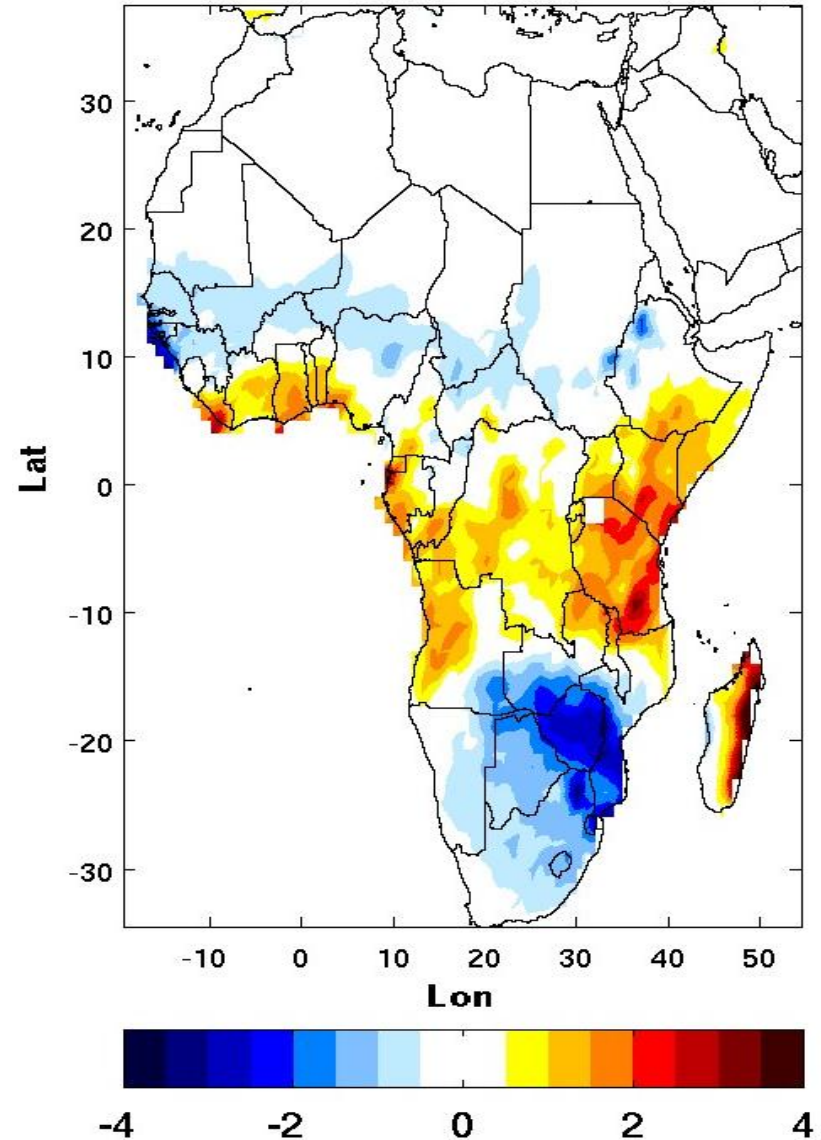
# Dominant mode of seasonal precipitation anomaly, 1982 – 2010

# Dominant mode of Jul-Sep precipitation anomaly and SST, 1982 – 2010

JAS GPCP Rainfall (82−10): PC #1
PC Loading Coefficients

JAS GPCP Rainfall (82−10): PC #1
Percentage of Variance Explained = 21.8 %

Global JAS GPCP SST Anomaly (82−10)
Point Correlation w/ JAS GPCP PC #1 (Significant at the 95% Level)

JAS Model SST Teleconnection

GPCP
Global JAS GPCP SST Anomaly (82-10)
Point Correlation w/ JAS GPCP PC #1 (Significant at the 95% Level)
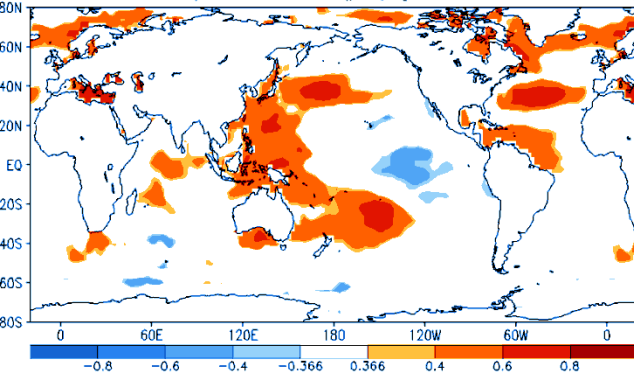
CFSv1
Global JAS CFSv1 SST Anomaly (82-09)
Point Correlation w/ JAS CFSv1 PC #1 (Significant at the 95% Level)
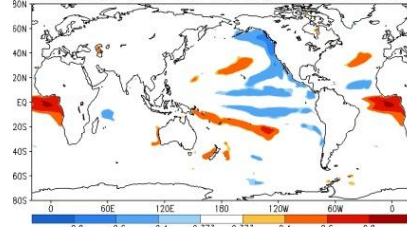
CFSv2
Global JAS CFSv2 SST Anomaly (82-10)
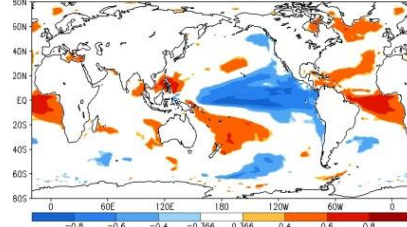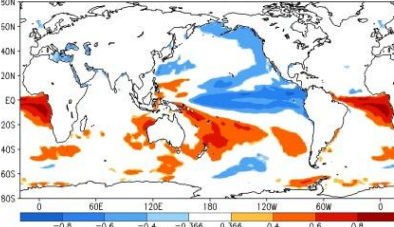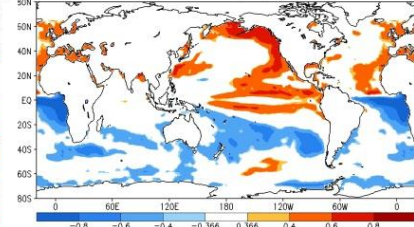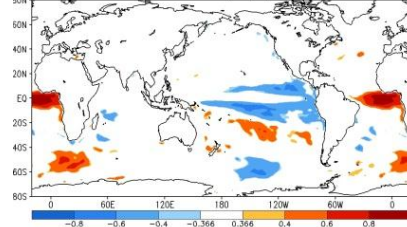Point Correlation w/ JAS CFSv2 PC #1 (Significant at the 95% Level)
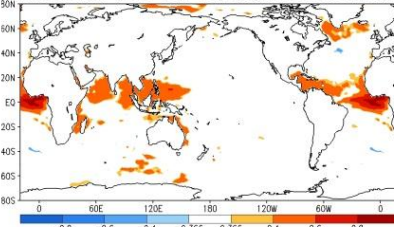
CMC1
Global JAS CMC1 SST Anomaly (82-10)
Point Correlation w/ JAS CMC1 PC #1 (Significant at the 95% Level)
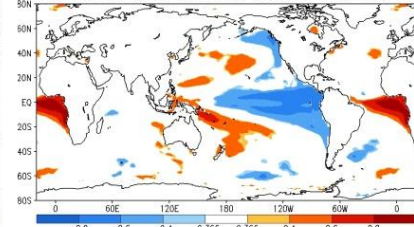
CMC2
Global JAS CMC2 SST Anomaly (82-10)
Point Correlation w/ JAS CMC2 PC #1 (Significant at the 95% Level)

ECHAMA
Global JAS ECHAMA SST Anomaly (82-10)
Point Correlation w/ JAS ECHAMA PC #1 (Significant at the 95% Level)

ECHAMF
Global JAS ECHAMF SST Anomaly (82-10)
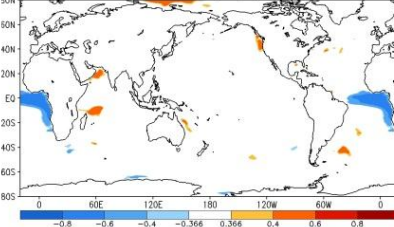Point Correlation w/ JAS ECHAMF PC #1 (Significant at the 95% Level)

GFDL
Global JAS GFDL SST Anomaly (82-10)
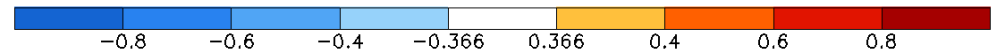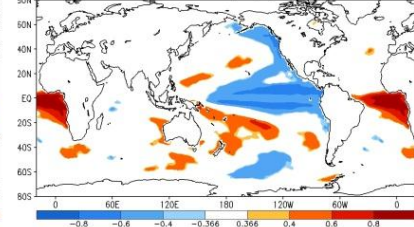Point Correlation w/ JAS GFDL PC #1 (Significant at the 95% Level)

NASA
Global JAS NASA SST Anomaly (82-10)
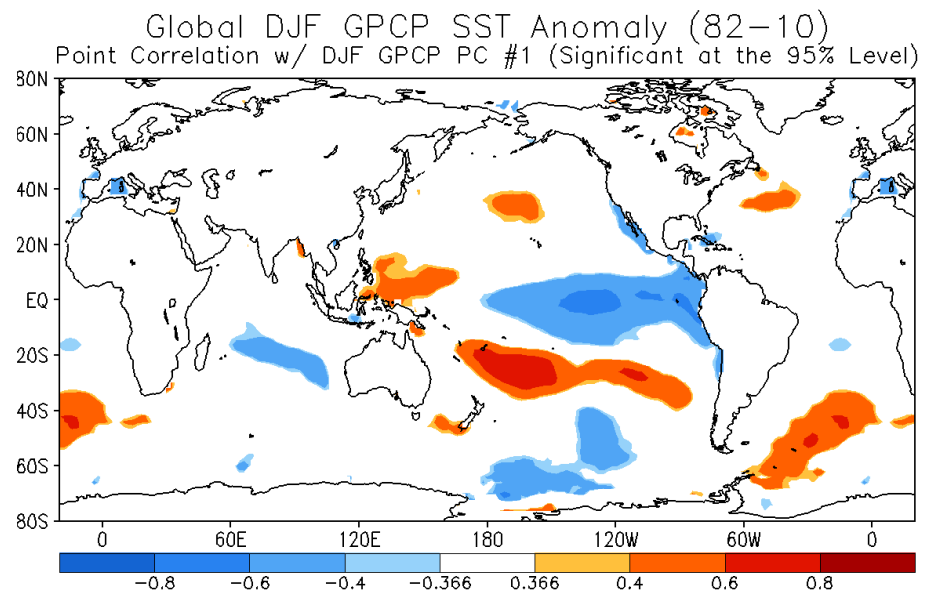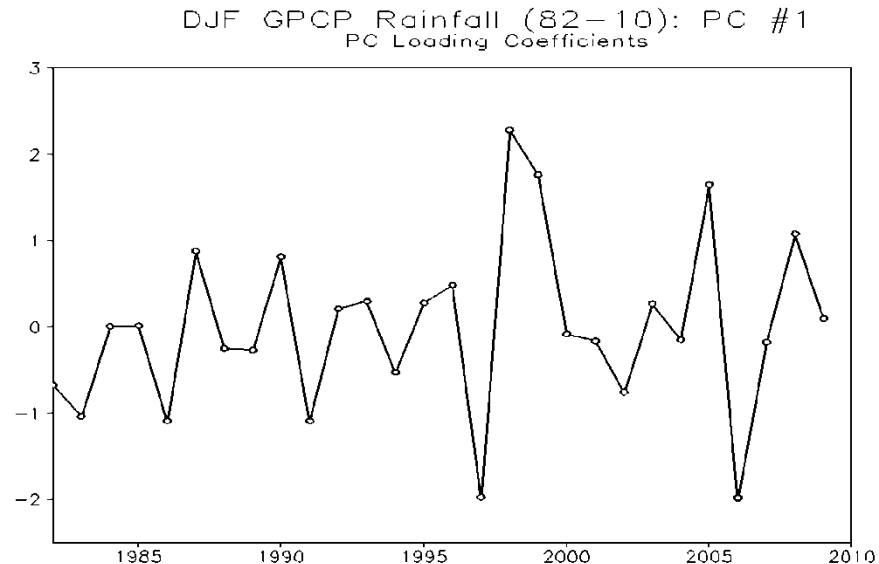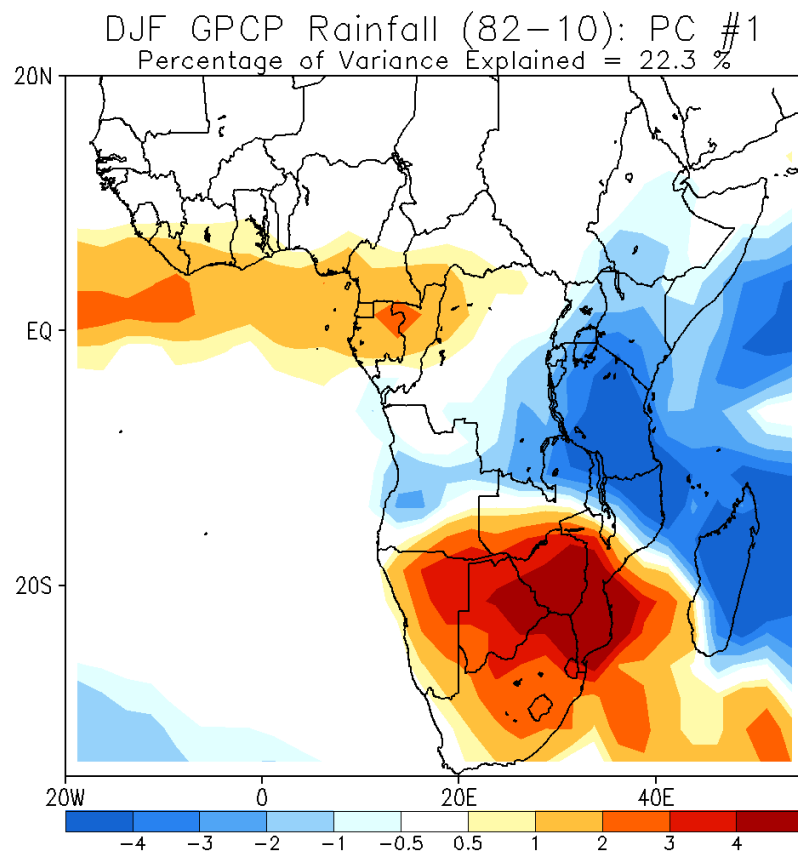Point Correlation w/ JAS NASA PC #1 (Significant at the 95% Level)

ENSM
Global JAS ENSM SST Anomaly (82-10)
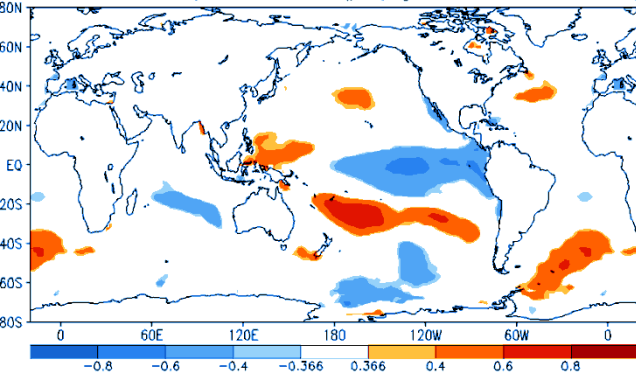Point Correlation w/ JAS ENSM PC #1 (Significant at the 95% Level)

Dominant mode of Dec-Feb precipitation anomaly and SST, 1982 – 2010
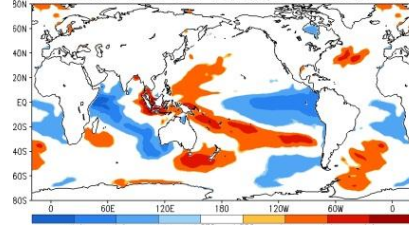
DJF Model SST Teleconnection

GPCP

Global DJF GPCP SST Anomaly (82–10)
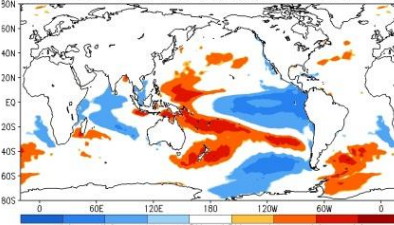Point Correlation w/ DJF GPCP PC #1 (Significant at the 95% Level)

CFSv1

Global DJF CFSv1 SST Anomaly (82–09)
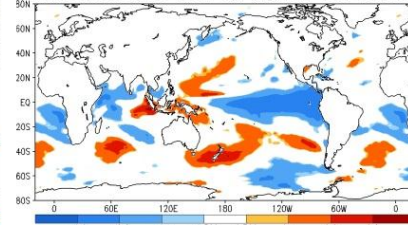Point Correlation w/ DJF CFSv1 PC #1 (Significant at the 95% Level)

CFSv2

Global DJF CFSv2 SST Anomaly (82–10)
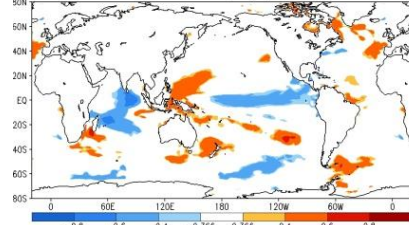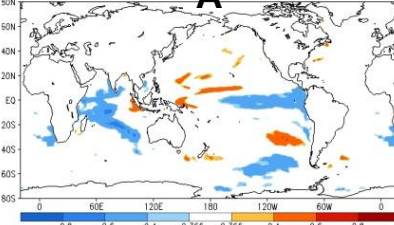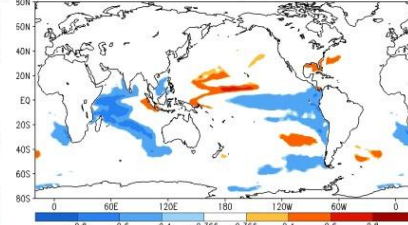Point Correlation w/ DJF CFSv2 PC #1 (Significant at the 95% Level)

CMC1

Global DJF CMC1 SST Anomaly (82–10)
Point Correlation w/ DJF CMC1 PC #1 (Significant at the 95% Level)

CMC2

Global DJF CMC2 SST Anomaly (82–10)
Point Correlation w/ DJF CMC2 PC #1 (Significant at the 95% Level)

ECHAMA

Global DJF ECHAMA SST Anomaly (82–10)
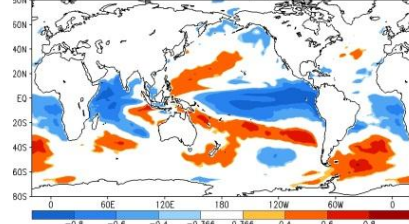Point Correlation w/ DJF ECHAMA PC #1 (Significant at the 95% Level)

ECHAMF

Global DJF ECHAMF SST Anomaly (82–10)
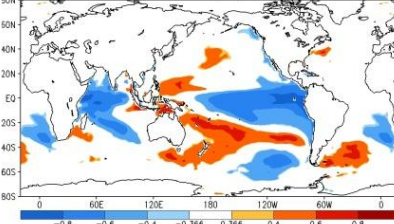Point Correlation w/ DJF ECHAMF PC #1 (Significant at the 95% Level)

GFDL

Global DJF GFDL SST Anomaly (82–10)
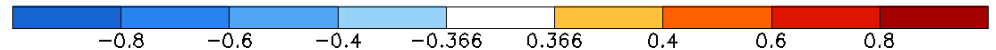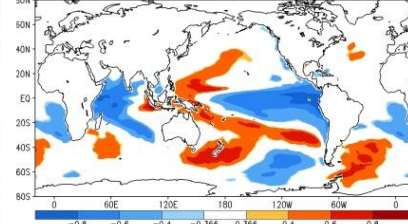Point Correlation w/ DJF GFDL PC #1 (Significant at the 95% Level)

NASA

Global DJF NASA SST Anomaly (82–10)
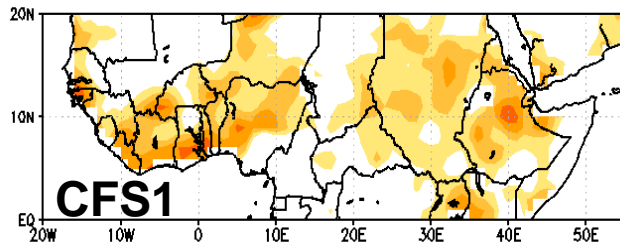Point Correlation w/ DJF NASA PC #1 (Significant at the 95% Level)

ENSM

Global DJF ENSM SST Anomaly (82–10)
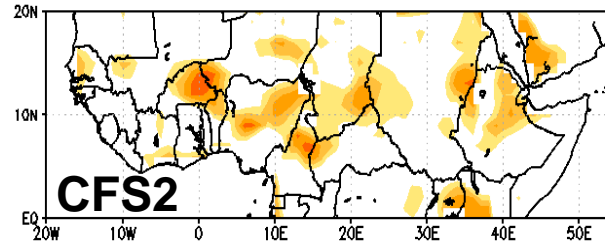Point Correlation w/ DJF ENSM PC #1 (Significant at the 95% Level)

Skill maps Northern Sub-Saharan Africa
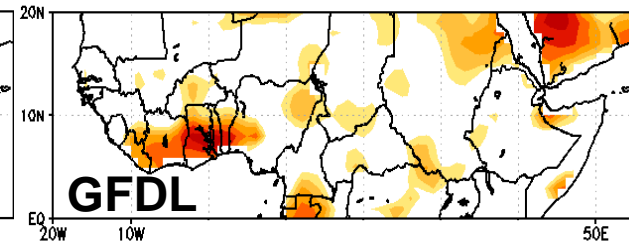# Jul-Sep 1982-10, June IC
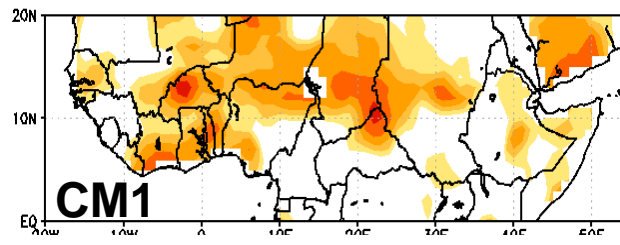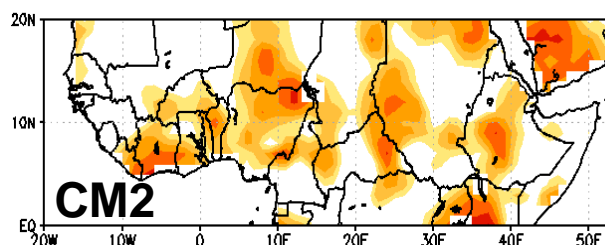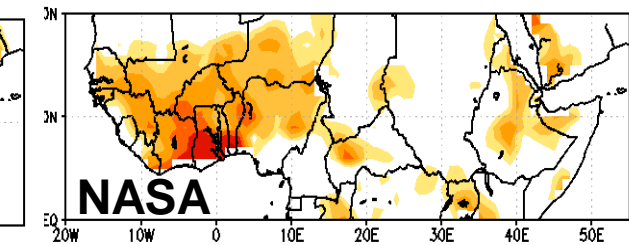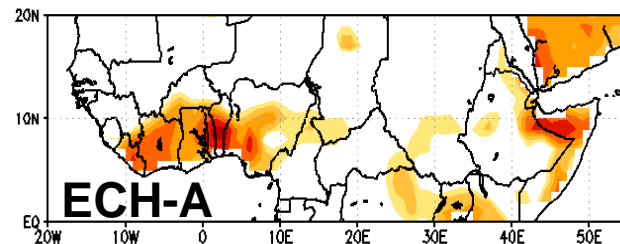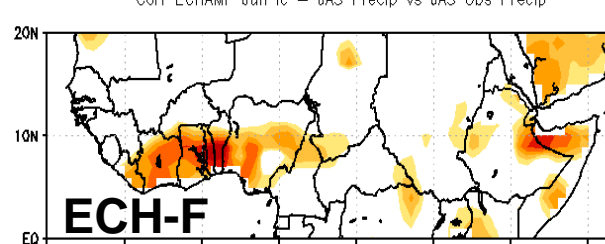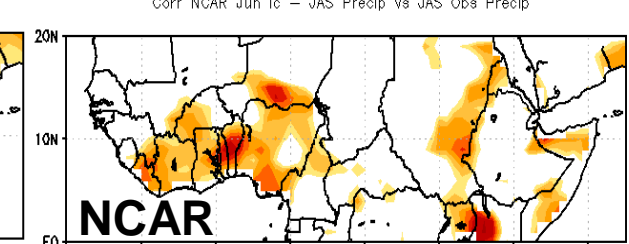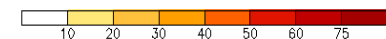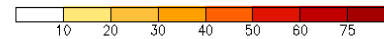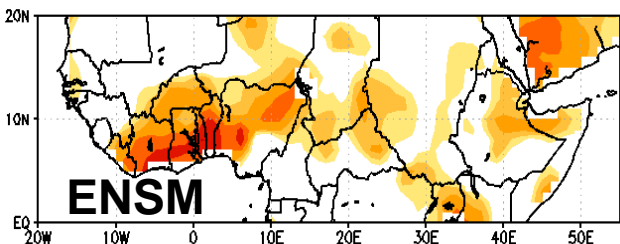
Correlation in percentages
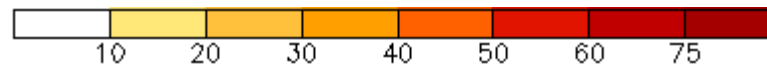
Skill maps Eastern Africa
Oct-Dec 1982-10, Sep IC
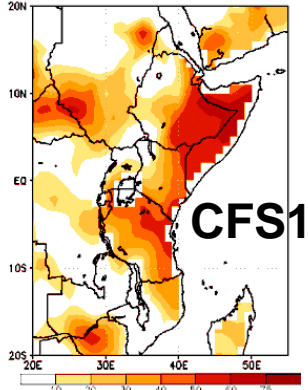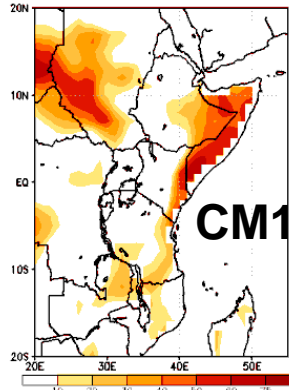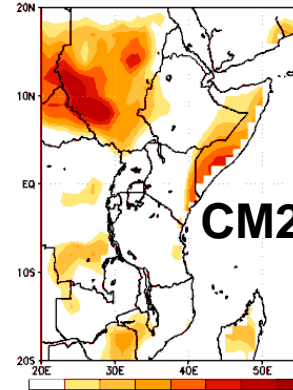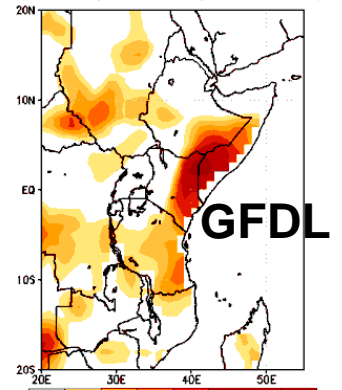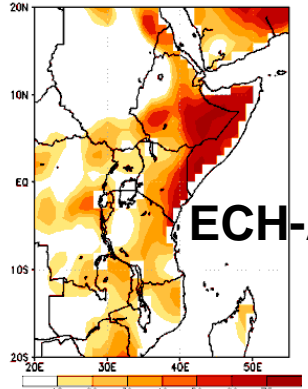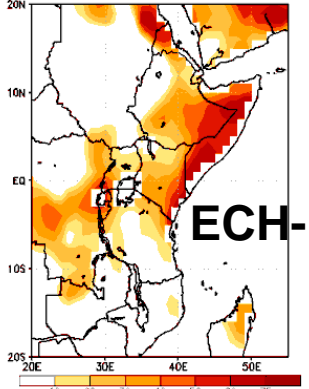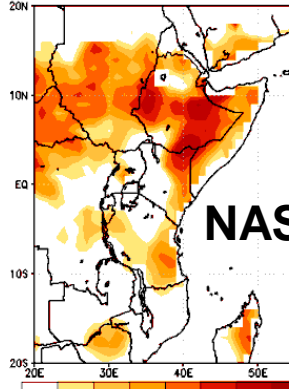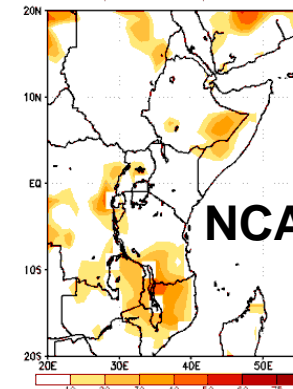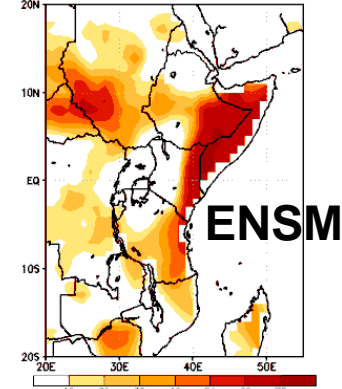
Correlation in percentages
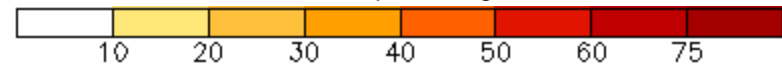
Skill maps Southern Africa
Dec-Jan 1982-10, Nov IC
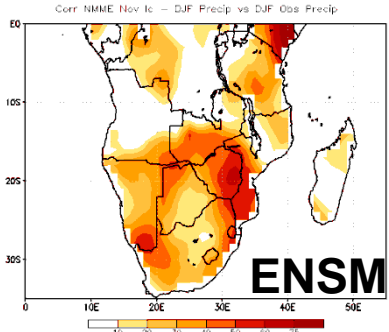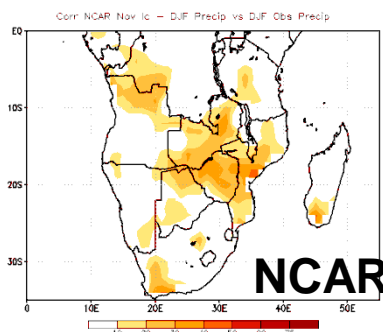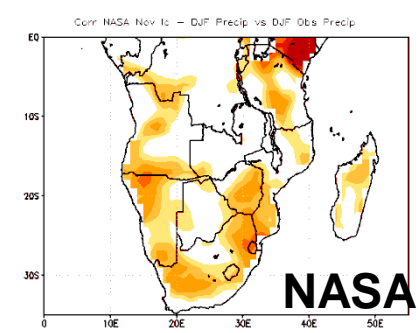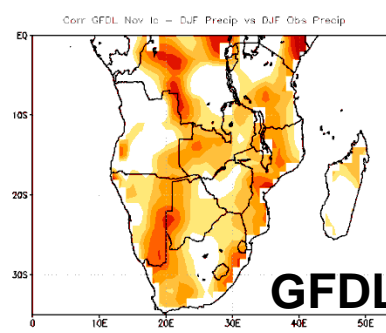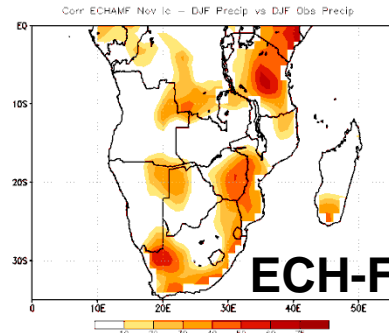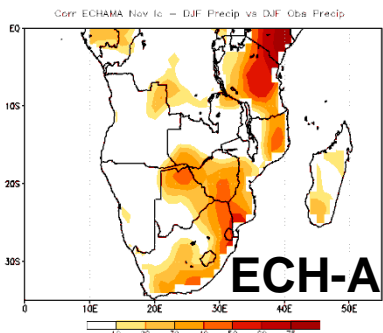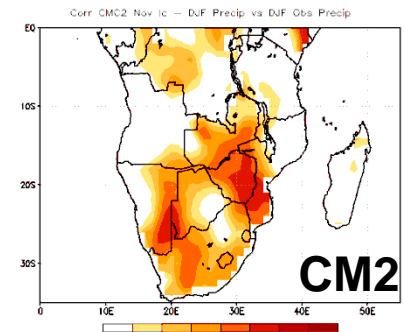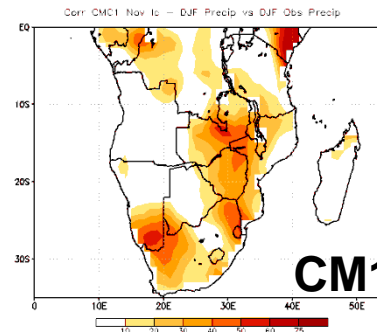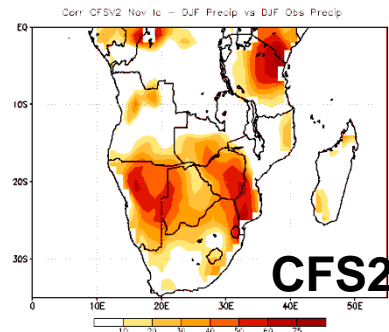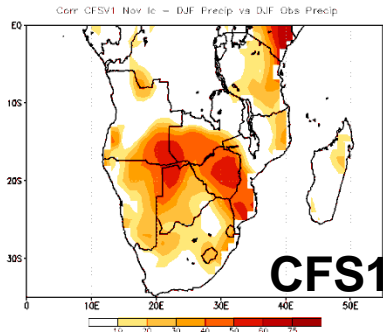
Correlation in percentages
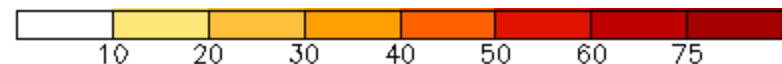
Sahel Jul-Sep, June IC
Mean anomaly correlation models and after CCA corrections

EXP	CFSv1	CFSv2	CM1	CM2	ECH-A	ECH-F	GFDL	NCAR	NASA	ENSM
Fcst	0.08	0.08	0.26	0.08	-0.30	-0.32	0.01	-0.21	0.22	0.03
CCA-Correc	0.24	0.14	0.30	0.20	**0.38**	**0.50**	-0.08	**0.38**	-0.03	0.34

ECHAM-F Skill map after CCA correction

Pearson Correlation(Skill Scores)   0.498484
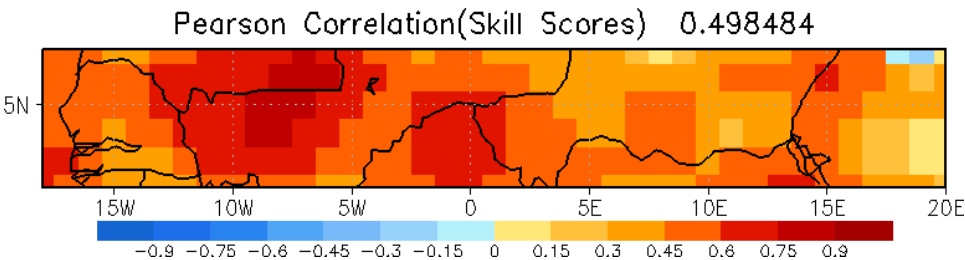
East Africa Oct-Dec, Sep IC
Mean anomaly correlation models and after CCA corrections

EXP	CFSv1	CFSv2	CCM1	CCM2	ECH-A	ECH-F	GFDL	NCAR	NASA	ENSM
Fcst	**0.38**	0.28	0.03	-0.02	0.05	0.37	0.27	-0.06	0.19	0.25
CCA-Correc	0.30	**0.43**	**0.36**	**0.38**	**0.54**	**0.52**	0.25	0.17	0.30	**0.41**

**ECHAM-A Skill map
after CCA correction**

Pearson Correlation(Skill Scores)   0.543602
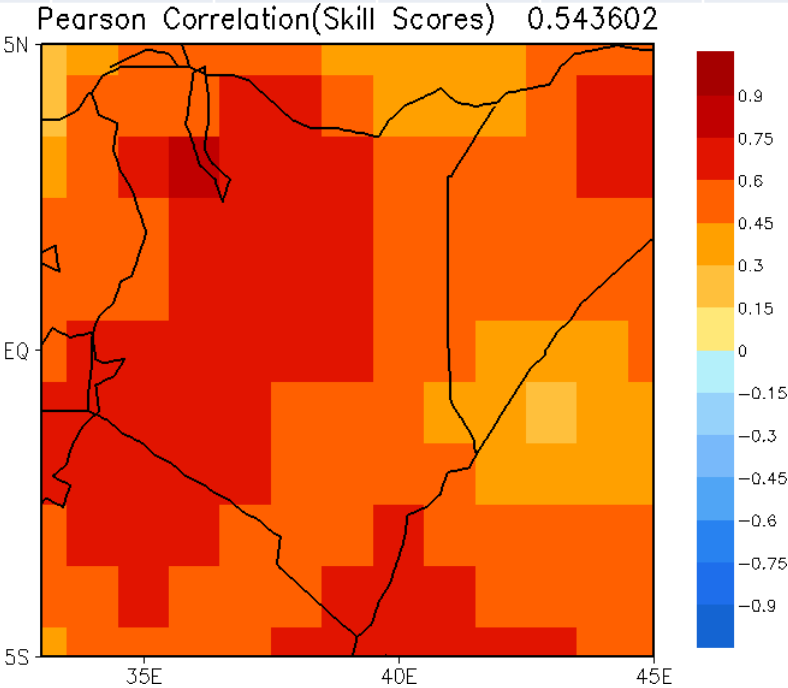
Southern Africa Dec-Jan, Nov IC
Mean anomaly correlation models and after CCA corrections

EXP	CFSv1	CFSv2	CCM1	CCM2	ECH-A	ECH-F	GFDL	NCAR	NASA	ENSM
Fcst	0.31	0.29	0.26	0.35	0.27	0.22	0.25	0.14	0.19	**0.39**
CCA-Correc	**0.39**	0.33	**0.38**	0.34	0.23	0.22	0.27	0.25	0.27	**0.38**

**ENSM Skill map
after CCA correction**

Pearson Correlation(Skill Scores)   0.381659
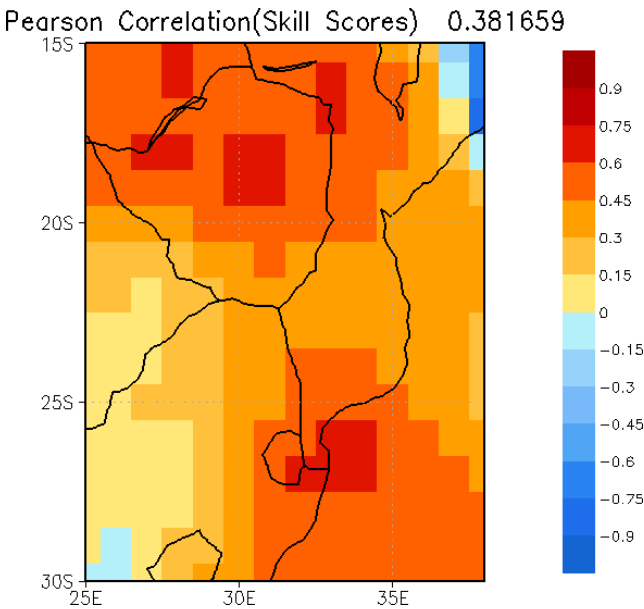
Summary

- This study has shown that only a few members of NMME have the ability to depict the principal mode of variability of the African seasonal rainfall and associated teleconnection patterns.

- NASA is the only model that depicts the rainfall dipole pattern over West Africa. None of the models depicted the recent SST trends associated with the precipitation dipole pattern over West Africa.

- However, the models diagnosed reasonably well the precipitation anomaly dipole between equatorial eastern Africa and southern Africa and the associated SST teleconnections.

- Models tend to be skillful along coastal Guinea in Jul-Sep, Jun IC, and along coastal Kenya and southern Somalia in Oct-Dec, Sep IC with correlation values exceeding 0.6.

- The Ensemble mean of the NMME does not outperform the individual models. Applying CCA corrections increase area-average forecast skill in most of the forecast experiments.